



THE EPIDEMIOLOGY OF UPPER LIMB FRACTURES AND DISLOCATIONS IN CHILDREN AND ADOLESCENTS

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ABSTRACT

Background: The aim of the study was to determine the epidemiology of upper limb injuries that required hospitalization in the population of more than 140,000 children.

Material and methods: A retrospective analysis of epidemiological data collected from 583 children treated at the Paediatric Surgery Department of Specialistic Hospital in Krakow in the years 2012-2015 because of upper limb fracture/dislocation. Age, sex, circumstances of the incident, type of fracture and the associated damage were evaluated.

Results: Upper limb fractures and dislocations together accounted for 38% of all hospital admissions due to injuries of different parts of the body. Median age of subjects was 9.6 years with a range from 2 months to 17 years. It was found that the main causes of injuries were one-storey falls (30%), second-storey falls (22.5%) and traffic accidents (12.5%). The most common fractures involved: the distal epiphysis of the radius and ulna (41.5%), then shafts of the bones of the forearm (25.5%) and the distal epiphysis of the humerus (17.3%). In the analyzed material, 36% of children suffered fractures/dislocations at home and 29% at school. 19% of fractures in children were sustained during sports activities.

Conclusion: Upper limb fractures and dislocations are the leading traumatic cause of hospitalization of children and adolescents in the surgical ward. Upper limb fractures and dislocations usually occur at home and its surroundings and at school, especially during sports activities. A one-storey fall is the most common cause of these injuries. In traffic accidents, pedestrians usually suffer injuries.

Keywords: Adolescent, Child, Epidemiology, Fractures, Upper Extremity.

1. Background

The epidemiology of upper limb fractures and dislocations have altered over the last few years due to the social, economic and demographic changes. This issue is the subject of very few studies in the literature. After head injuries, upper limb injuries constitute the largest percentage of traumatic causes of children and adolescent hospitalizations. A detailed analysis of injuries is needed for a better understanding of this problem and the age-related risk factors in childhood and adolescence. The answer to the questions- how, where and why injuries of the upper limb occur - is the starting point to form recommendations of preventive measures aimed to reduce the incidence of this medical problem. The report prepared by the European Commission Public Health Programme entitled "Tools to Address Childhood Trauma, Injury and Children's Safety" showed a need to develop and implement effective policy and programs in the area of fall prevention, and cycling children safety[1]. The most common places of injuries are house with its surroundings and the school. According to the data, many schools do not

provide the safe learning environment. In the school year 2003/04, 149,494 accidents were registered in Polish schools and educational institutions including 88 deaths of students and 1,248 serious injuries. Thus, epidemiological data are necessary to develop and introduce educational programs for parents, carers, teachers and children in order to implement the principles of injuries prevention.

The aim of the study was to determine the epidemiology of fractures and dislocations of the hand, forearm, arm and shoulder which required hospitalization in the population of more than 140,000 children.

2. Material and methods

The Department of Paediatric Surgery of the Stefan Zeromski Specialistic Hospital in Krakow is one of the two departments covering 800,000 population of children from the urban area and the surroundings of Krakow. In years 2012-2015, 4,836 children were hospitalized in the ward, including 1,836 (38%) due to injuries. Upper limb fractures and dislocations were the cause of 583 (12%) hospitalizations. 583 children and adolescents treated

because of fracture or dislocation of the upper limb were included to retrospective epidemiological analysis. The study, was based on analysis of available medical records, assessed age, sex, circumstances of the incident, type of injury and the associated injuries. Patients from the study group were assigned to individual age groups: 0-2 years, 3-6, 7-12 and 13-17 years. The results were analysed using the Statistica program. The chi-square correlation test was used separately for each age group to determine relationships between the age of children and circumstances of fracture and between the age and place of fracture.

3. Results

The study group of 583 patients with fractures or dislocations of the upper limb included 362 (62%) males and 221 (38%) females. Table 1 presents fractures and dislocations in relation to gender and the side of injury based on the International Classification of Diseases ICD-10 with an annual breakdown.

In the analysed group, fractures/dislocations most commonly occurred in children in age of 3-6 years and it was 33% of the total number of patients; Injuries were less frequent in children age group 0-2 years (10%). The most typical fractures involved the forearm bones and distal epiphysis of the radius and ulna including growth plate, occurred in 229 (41.4%) children. Fractures both forearm bone shafts were diagnosed in 141 (25.5%) children, while supracondylar fracture of the humerus was recognized in 96 (17.3%) cases. We have also noted fracture and dislocation of the metacarpal bones and the phalanges in a total of 68 (11%) children. The data show that at the age of 3-6 years fractures in the vicinity of the elbow joint were the most common, including supracondylar fracture of the humerus. The age group 7-17 years was dominated by fractures of metaphysis and distal epiphysis of the radius and ulna (Table 2 and 3).

In the analysed material, 210 (36%) children had fractures/dislocations at home, and 170 (29%) at school. In 112 (19%) subjects, fractures were sustained during sports activities and in 72 (12.5%) as a result of traffic accidents (Table 4). The most common cause of fractures was a one-storey fall (on same plane) - 167 (30%) cases, second-storey fall (between planes) in 131 (22.5%) patients, and a fall from a bicycle - 81 (13.9%). Children from the age groups 0-2 and 3-6 years most often had injuries at home, including falls from the changing table, bed, cot and furniture. In the group of 7-12 and 13-17 years old, injuries more frequently occurred in the vicinity of home and school, where fractures were sustained during sports activities as well as fights between peers. Sports-related injuries were equally common in contact sports and athletics. In all analysed age groups, traffic accidents were the third most common cause of fractures/dislocations. Table 5. In the study group, 61 (10.5%) patients had a concomitant damage, usually head trauma - 30 (41.6%) children (Table 6). Fractures/dislocations of the upper limb were most often in children in the age group 3-6 and 7-12. Typically, the

incidence of fractures gradually decreases with age. However, in the age group 3-6 years, there is a similar distribution of fracture location as in the age group 7-12 years. As for age, the analysed fractures/dislocations took place under specific circumstances. In the age group of 7-12 and 13-17 years, injuries were most often sustained during sports activities as a part of PE classes (school); in younger age groups they constituted a small percentage. The distribution of injuries sustained in traffic accidents was similar in all age groups. A one-storey fall (on same plane) leading to fracture was equally common in all age groups.

4. Discussion

Even though fractures and dislocations of the upper limb are the most common cause of morbidity in children, reports on their epidemiology are rare. The study presents retrospective analysis of upper limb fractures/dislocations and is a contribution to the process of epidemiological data gathering. In the analysed material, upper limb fractures/dislocations were predominant in boys, which can be explained by their increased activity and more frequent practice of sports. A higher number of fractures in the age group 7-12 years, which was demonstrated in the material, is also convergent with literature data [2,3,4]. However, some reports indicate that the number of upper limb injuries increases with age [1,5]. The study revealed a slightly higher rate of injuries of the left upper limb (Left/Right = 301/282), but there was no correlation between the side of fracture/dislocation and age, gender and circumstances of the incident. In the study conducted by Karl and Hedstrom, the distribution of injuries was similar [2,6]. Slightly larger exposure of the left upper limb to injuries can be explained by the smaller dominance of the left limb, and therefore its poorer neuromuscular coordination. In addition, when the right upper limb performs the main action, the left one is used as a protective extremity [7].

The study found no relationship between the number of injuries and the time of day. The time of the day of fracture/dislocation was distributed equally between noon, afternoon and evening. This is due to the fact that children maintain their activity at the constant level throughout the day [6, 8]. However, it was remarkable that fractures were more frequent in spring (42%) and summer time (36%) than in autumn (14%) and winter (16%). This observation stems from the increased physical activity of children and young people in spring and summer time when the weather favours staying outdoors and practicing sports. Seasonal variations for all fractures have been described by other authors [2,6]. Fractures/dislocations usually occurred in preschool and school children, in the age group 3-12 years (62%), less frequently in children younger than 2 years old (10%). Literature data confirm an increased incidence of upper limb injuries in the preschool and school age [8,9].

In all age groups, fractures mainly included forearm fractures (66.9%), then supracondylar fracture of the humerus (17.3%). Dislocations generally involved small

joints of the hand. This is in accordance with the observations of Clark and Barr who confirmed that fractures of the forearm constituted the largest group. The authors also indicated that supracondylar fracture usually occurred in children between 6 and 9 years of age [8,10].

It was unambiguously demonstrated that injuries were most often caused by one-storey falls (29.6%) and second-storey falls (22.5%), with a similar frequency in all age groups. According to findings of other authors, one-storey falls, falls from a height and traffic accidents were the prevailing circumstances of injures [5,6,10].

In 10.5% of upper limb injuries were accompanied by other trauma, such as superficial head injury in 21 (29 %) patients, brain concussion in 9 (12.5%) subjects, and soft tissue contusion of the upper limb in 7 (9.7%) patients, thigh and lower leg in 9 (12.5%) cases. This is consistent with currently available literature reports [7, 11]. It should be emphasized that the house (36%) and school (29%) and their surroundings are a location of most fractures/dislocations. This observation was confirmed by our study results and literature reports. Many schools still do not provide safe conditions for learning and physical activity. In the 2003/04 school year, 149,494 accidents were registered in Polish schools and educational institutions, including 88 deaths of students and 1,248 serious injuries. In our material, fractures caused by traffic accidents account for 11% of all these types of injuries. Few authors estimate this number at 2%, however, in traffic accidents, associated injuries are more common [12]. It should be emphasized that pedestrians are almost twice more likely to sustain an injury than passengers and this observation applies to all age groups.

Based on our material, we can conclude that 10% of children aged 0-2 years were hospitalized because of fractures/dislocations. Injuries in the youngest age group took place mainly at home (87%) or were a result of traffic accidents - the remaining 13%. In the age groups 7-12 and 13-17 years, sports-related activities were the third most common cause of injuries. There was a comparable number of fractures/dislocations in contact sports and athletics. In group 0-2 years injuries are rarely accidental and result from the lack of due care or child maltreatment by caregivers. The analysed data do not allow to draw a conclusion on the percentage of fractures related to domestic violence and abuse.

The high incidence of upper limb injuries in children and adolescents with their consequences, such as growth limb disorders and angular and rotation deformities, which can lead to disability, are the primary cause of actions aimed at reducing injury rates. Literature presents works evaluating the effectiveness of preventive measures, such as the recommendation to wear helmets and protective gear while cycling, skating and skateboarding. It also

involves the need to change habits and awareness among parents, educators and children to reduce the incidence of injuries and their consequences [1].

The report quoted at the beginning, developed by the European Commission Public Health Programme and entitled "Tools to Address Childhood Trauma, Injury and Children's Safety " presents the assessment of nine key areas of injuries prevention, including safety of pedestrians, passengers, cyclists, as well as safety while using a scooter, motor bicycle, staying in the water and falls prevention. The evaluation presented in this report shows a need to plan and implement effective policy and programs in the area of falls prevention, as well as safety of a child as a cyclist [1]. These data indicate a necessity of implementing preventive measures and legislative changes aimed at improving safety on roads. There is a need to work and introduce programs for prevention and education for parents, carers, teachers and children in order to teach rules to reduce the incidence of injuries at home and its surroundings. The exemplary actions in this area include the introduction of legislation limiting the speed of vehicles in residential areas (e.g. around schools, playgrounds), provisions requiring the mandatory use of helmets by those who go by bicycles, mopeds or scooters and their passengers, as well as regulations imposing the use of seat belts in children and adolescents in cars and the transport of children and adolescents up to the age of 13 years in the rear seats of motor vehicles [1,13]. Literature indicates the need to direct primary, secondary and tertiary prevention towards improving supervision and care of children [1].

5. Conclusions

1. Upper limb fractures and dislocations in children and adolescents are a major medical and socio-economic problem requiring in-depth epidemiological studies.
2. Fractures of the bones of the forearm and supracondylar fracture of the humerus are the most common. Dislocations are less numerous and mainly involve the joints of the hand.
3. Upper limb fractures and dislocations usually occur at home and its surroundings and at school, especially during sports activities.
4. A one-storey fall is the most common cause of the discussed injuries. In traffic accidents, pedestrians more often suffer from injuries.
5. There is a need to develop and implement programs for prevention and education for parents, carers, teachers and children in order to prevent injuries.

Tables

Table 1. The number of fractures and dislocations recorded in subsequent years in relation to gender and the side of damage, on the basis of the ICD-10 classification.

<i>Diagnosis according</i>	<i>Year 2012</i>	<i>Year 2013</i>	<i>Year 2014</i>	<i>Year 2015</i>	<i>Site of lesion</i>
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<i>toICD- 10</i>	F*	M**	F	M	F	M	F	M	Left	Right
S42.0	1	2	0	2	0	3	2	3	9	4
S42.2	1	0	0	2	1	0	3	0	4	3
S42.3	0	2	1	1	1	1	1	4	5	6
S42.4	15	14	13	9	13	10	7	15	65	31
S43.0	0	0	0	1	0	1	0	0	1	1
S43.1	0	0	0	1	0	1	0	0	0	2
S52.0	1	0	0	0	0	1	0	0	0	2
S52.1	1	0	0	0	1	1	0	1	2	2
S52.2	1	0	0	1	1	2	1	1	4	3
S52.3	1	4	2	3	2	3	3	6	8	16
S52.4	5	26	6	8	9	25	8	16	56	47
S52.5	11	19	12	14	11	21	11	31	62	68
S52.6	7	17	8	18	11	15	8	13	43	54
S52.7	1	1	0	0	0	0	0	0	2	0
S52.8	0	0	1	0	2	2	3	1	5	4
S53.1	1	1	1	1	0	0	0	2	2	4
S62.2	2	0	0	1	0	2	1	0	4	2
S62.3	3	1	2	3	0	2	1	3	10	5
S62.5	0	1	0	1	2	0	5	0	5	4
S62.6	1	4	3	5	3	4	2	4	8	18
S63.1	3	2	0	0	0	2	4	1	6	6
Sum	55	94	49	71	57	96	60	101	583	

*F=female, **M=male.

Table 2. Numerical and percentage values of upper limb fractures in individual age groups.

<i>Age year s</i>	<i>Values M*:F**</i>	<i>Fracture of</i>							
		Hand	Distal epiphysis of radius	Proximal epiphysis of radius and ulna	Diaphysis of radius or ulna	Supracondylar fracture of humerus	Humerus	Clavicular	Multiple fractures
0-2	41:22	6	26	0	13	16	1	0	0
3-6	125:66	16	88	1	39	44	4	2	0
7-12	91:72	16	63	4	47	21	5	6	1
13-17	92:52	21	50	1	44	15	8	5	1
SUM	349:212	56	227	6	143	96	18	13	2
%		9,8 %	40%	0,9%	24,8%	16,9%	2,3%	1,8%	0,3%

*M=male, **F=female

Table 3. Numerical and percentage values of upper limb dislocations in individual age groups

Age years	Values M*:F**	Luxation of				Sum
		Shoulder	Acromioclavicular joint	Elbow	Intraphalangeal joints	
0-2	0:0	0	0	0	0	0
3-6	2:2	0	0	1	3	4
7-12	4:2	0	0	1	5	6
13-17	7:5	2	2	4	4	12
SUM	13:9	2	2	6	12	22
%		0,3%	0,3%	0,9%	1,7%	

*M=male, **F=female

Table 4. Percentage and numerical distribution of places where trauma took place in individual age groups

Age years	Quantity	Road traffic accident		Sport activities		Home	School	Others
		Pedestrian	Passenger	Athletics	Contact sports			
0 - 2	62	8	0	0	0	54	0	0
3 - 6	195	12	8	2	0	113	58	2
7 - 12	169	13	7	23	23	26	68	9
13 - 17	157	15	10	33	31	17	44	7
Sum	583	48	25	58	54	210	170	18
%		8,2%	4,3%	9,9%	9,3%	36%	29,1%	3,1%

Table 5. Numerical distribution of circumstances directly leading to fractures in individual age groups

Circumstances/age in years	0 - 2	3 - 6	7 - 12	13 - 17
One-level fall	21	62	52	32
Fall from one level to another	18	39	38	36
Fall down the stairs	6	17	14	9
Fall from the furniture	3	7	3	2
Fall on skating, skiing, roller skates	0	15	7	20
Fall from bicycle	0	22	5	14

Road traffic accident with bicyclist	3	4	18	15
Road traffic accident -passenger	6	7	9	3
Road traffic accident- pedestrain	1	9	11	6
Cruching by objects	2	4	5	2
Others	2	9	7	18
Sum	62	195	169	157

Table 6. Injuries associated with fractures and dislocations

Associated injuries	
Head contusion	21
Brain concussion	9
Chest wall contusion	5
Abdominal wall contusion	8
Distortion of cervical spine	3
Distortion of lumbar spine	2
Distorsion of thoracic spine	2
Distorsion of ankle	3
Contusion of arm	5
Contusion of shoulder	2
Contusion of hip	3
Contusion of thigh and calf	6
Tibial fracture	2
Femoral neck fracture	1
Sum:	72

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